Space Weather Technical Forecast

Issued on Sunday, 15 May 2022 at 01:22 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 radio blackouts becoming increasingly Likely. Slight Chance of G1/Minor Geomagnetic Storm, peaking 16 May.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with frequent low-level C-class flares observed at GOES16 that increased in amplitude late in the UTC day. These peaked initially with a C3.6 at 14/1930UTC from fading AR3006 in the southwest, to be trumped shortly after by a larger C4.2 at 14/2016UTC from AR3010, and then in turn by a C5.7 at 14/2207UTC from a new northeastern limb sunspot group.

There were up to seven sunspot regions visible on the disc in the period, as although AR3008 faded in the north centre-disc, several new regions emerged. Two of these have yet to attain a number, and appear as a Dso/Beta and Hrx/Alpha immediately east of AR3011, a stable and unremarkable Bxo/Beta group in the northeastern quadrant. This portion of the sun is showing bright flux looping narrowly over the limb (e.g. in AIA171) and may yet reveal further groups in the coming 24 hours or so.

The front side remains dominated areally by the large and complex AR3007, although it now lacks its earlier Mt Wilson delta spot and manifests as an Eac/Beta, with a slight spreading trend evident and minor proliferation in its intermediate portions. To its southwest, a visually much-weakened remnant of AR3006 showed fading across the board, holding on as a Bxi/Beta by the period's end.

Rounding off the front-side tally of sunspot groups were AR3013 in the southeast, an unremarkable Axx/Alpha; and finally AR3010 in the east, an Esi/Beta, which showed spreading, penumbral decay and minor proliferation.

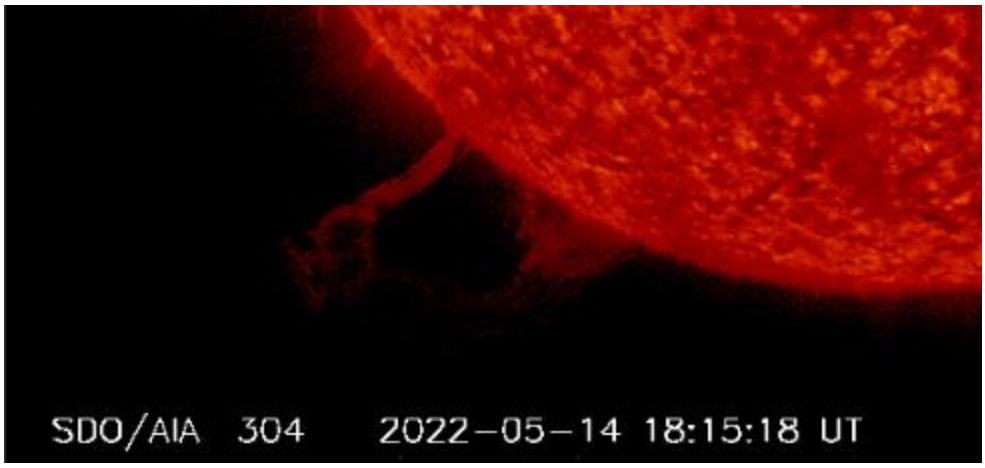

Figure 0a: Large low-latitude prominence erupton, seen heading southeast on evening coronagraph imagery to no likely effect at Earth.

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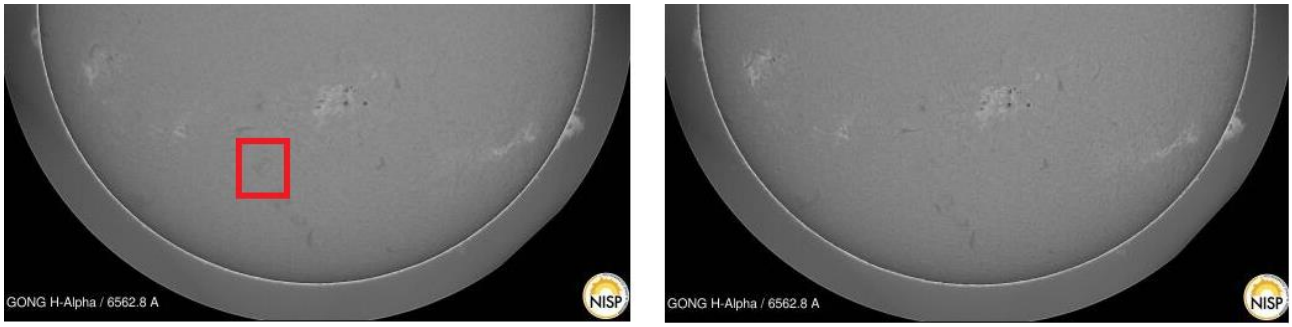

Figure 0b: Big Bear observatory view (14/2000UTC and 14/2100UTC) of a south-centre disc disappearing filament around 14/2000UTC. Imagery for any ejecta from this event is not yet available.

There remain numerous small filaments on the disc. A large prominence eruption occurred from the southeast around 14/1800UTC, with this event visible in coronagraphs but directed below the ecliptic plane to no effect at Earth. Another feature was seen to disappear gradually from the south-centre disc at 14/2000UTC on Big Bear H-Alpha imagery. This event is being watched for in coronagraphs, however at the time of writing, no Earth directed Coronal Mass Ejections (CMEs) have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1, showed a slightly enhanced behaviour through the course of the day. The source of this is uncertain, but perhaps best resembles a minor CIR into positive-polarity high speed stream. This has perhaps arisen from a small calved portion of the expected CH81/+ visible on the synoptic map, although this is not conclusive.

The solar wind speed started the 24 hours near 325km/s, but showed a rising trend to reach 450km/s by the end of the UTC day, with the solar wind density rising to just shy of 30ppcc before falling during the UTC evening as the possible high speed stream began in earnest. The IMF gradually rose over the course of the day, reaching as high as 21nT, with a fortunately mainly co-aligned north-south component that varied between +15 and -5nT. The phi angle was positive (away from the sun) throughout.

The net effect of these solar wind measures was nevertheless Quiet through the 24-hour period, perhaps aided by the IMF being largely co-aligned with Earth's field. Kp provisionally peaked at 2+ in the 09-12UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) has been at Background levels through the last 24 hours.

The high energy electron flux (greater than 2 MeV) has remained at Normal Background levels, with the corresponding electron fluence well below the Active (1e8 integrated pfu) threshold on a level trend. Observed fluence at 15/0001 UTC was 1.18e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity should be Low to Moderate, with M-class flares becoming slightly more Likely, and a Slight Chance of an X-class flare. The flare risk may trend a little higher through the period owing to an active northeastern solar horizon.

Solar Wind / Geomagnetic Activity: No CMEs feature in the forecast.

The current solar wind enhancement may be a minor precursor coronal hole to the expected

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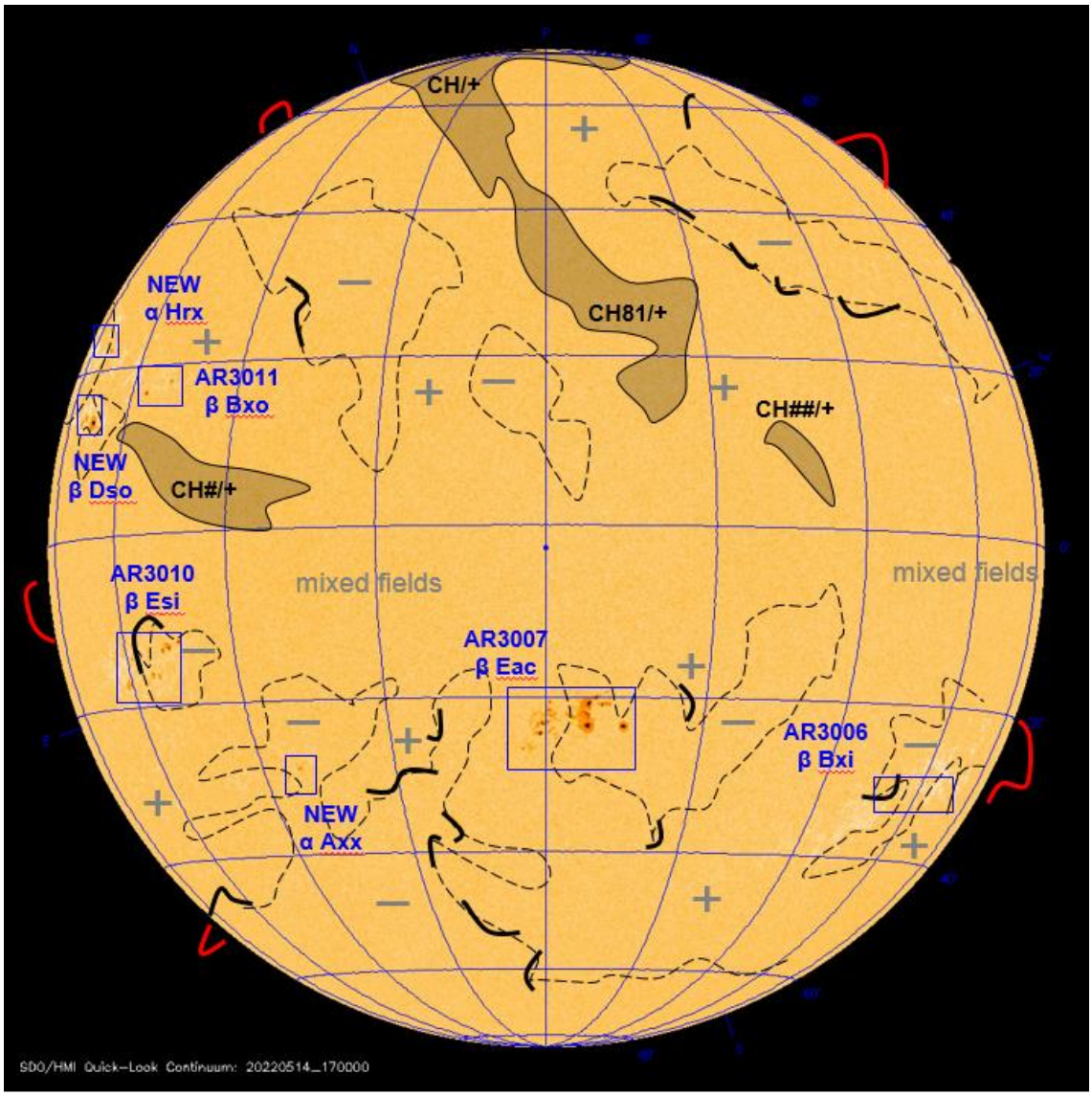
CH81/+, bringing forward a Slight Chance of Minor Geomagnetic Storm G1. This is the only expected enhancement in the four-day period, and a gradual reversion to Quiet conditions is expected by midweek UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to be at background levels during this period, although there is slight risk of an S1 or greater event, mainly due to AR3007 as it transits west from a central location.

The high energy electron flux (greater than 2 MeV) is forecast to remain at Normal Background to Moderate levels through much of the forecast period, but perhaps an increased chance of the diurnal peak reaching High levels from day three (Tuesday 17 May). The 24-hour electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period, but with a probable rising trend.

Figure 1. Solar Analysis Valid 14/1700UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-bound Coronal Mass Ejections (CMEs) feature in this forecast period.

Solar winds in the past 24 hours are strongly suggestive of CIR and positive polarity coronal hole-like influence. The source of this enhancement is not immediately clear, but it may be linked to the small orphaned portion of CH81/+ that appears further west than its parent on the solar synoptic map. In hindsight, there are suggestions of similar from STEREO A MAG and PLASTIC traces around 2.5 days upstream of Earth in the Parker spiral. Relative to earlier guidance, the risk of Minor Geomagnetic Storms is therefore brought forward slightly, with the assumed main event still arising from the main body of CH81/+, which ought to arrive on 16 May.

The above is the only expected enhancement of the solar wind due in the four days, and an increasingly Quiet outlook is therefore expected.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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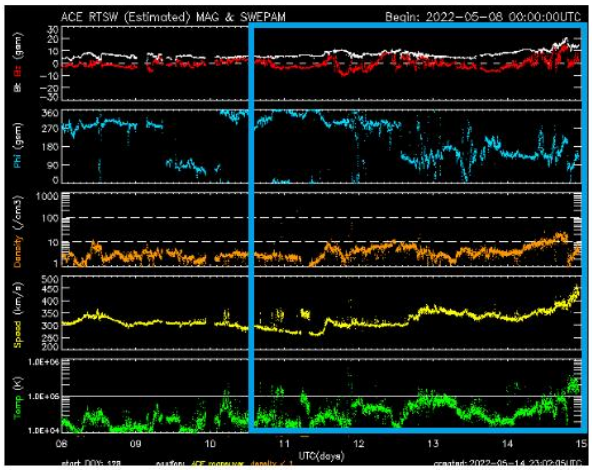
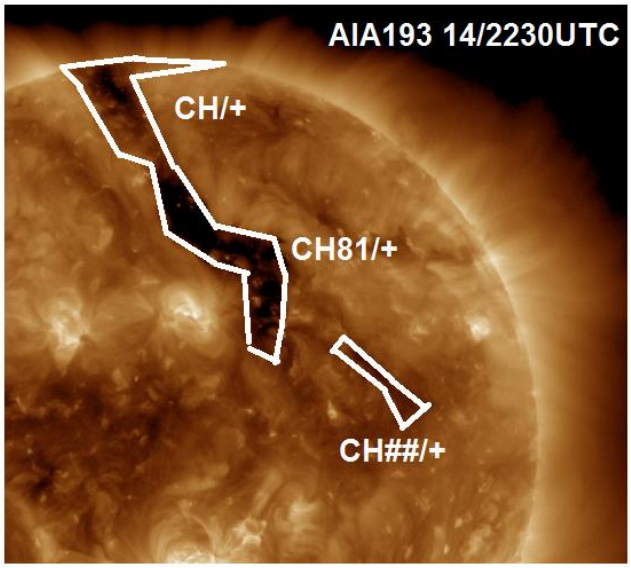
Figure 2: Rationale for current forecast: 7-day STEREO A MAG and PLASTIC plot showing analagous evolution at ACE in blue box, with the expected forecast evolution at ACE in red. The hypothetical cause of the current fast wind enhancement is a stronger than expected connection to the forerunning promontary of CH81/+, labelled CH##/+ on the AIA 193 image. The differences in e.g. phi angle between the ACE and STEREO A traces may perhaps be explained by their sampling different solar latitudes, perhaps falling either side of the current sheet - for STEREO A being 3 degrees further south.





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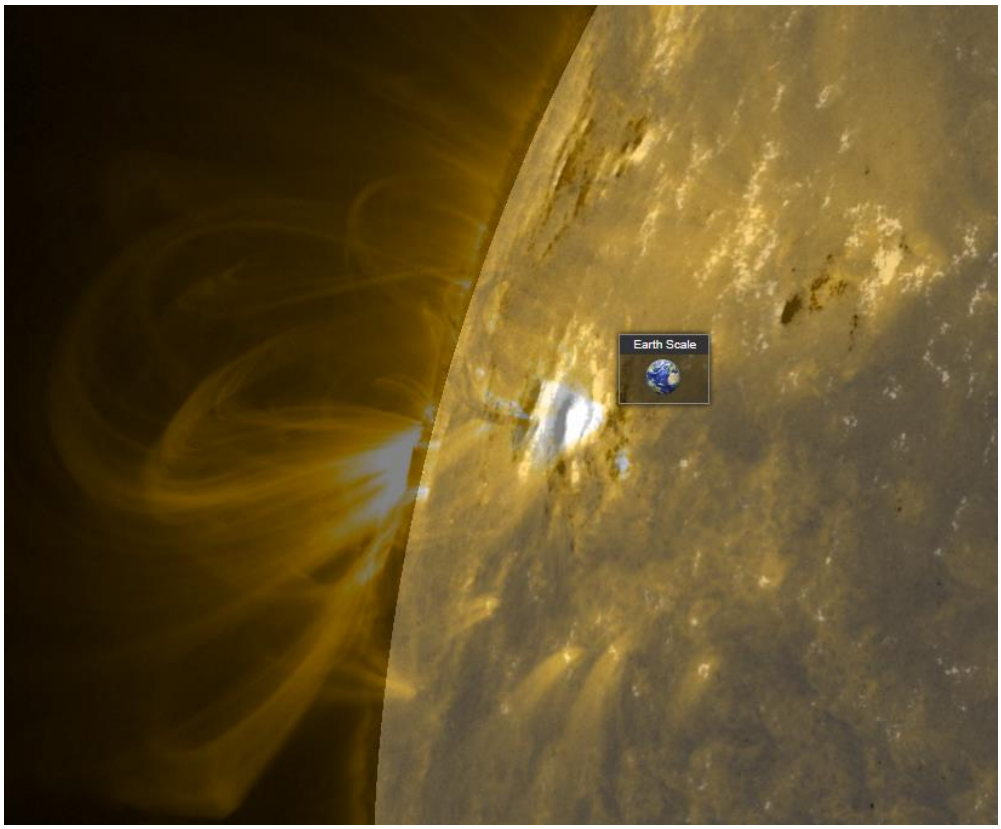
Radio Blackouts - X-Ray Flares:

The Earth facing side of the solar disc is expected to see an increase in population of sunspots in the period, with the northeastern limb appearing to harbour a large bright flux region(s) that should rotate onto the disc into the coming UTC working week. The exact contribution from these is uncertain, but they are likely to more than compensate for the loss of AR3006 early in the period, with this group fading in any case.

All considered, there is a slightly increasing risk of M-class flares, with a similar slight increase in the odds of isolated X-class flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	50	60	60	60
Very Active	R3 to R5 X Class	No	5	10	10	10

Figure 3: 14/2200UTC Composite image of the northeastern solar horizon in HMIB and AIA171, with Earth shown for scale. This area will form some of the main monitoring of the coming forecast period. Image processing courtesy of helioviewer.org.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is close to Background levels and is generally expected to remain at that level throughout the period. However, there is a slight chance of an S1 or greater event during the forecast period, primarily due to the presence of AR3006 in the southwest quarter, and AR3007 as it transits west from a central location.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) is expected to be at Normal background to Moderate levels during the first half of the forecast period, but may rise from Tuesday 17 May (day three) once the high speed stream originating from CH81/+ proper becomes established. The current slight enhancement is not thought strong enough to have an appreciable effect on electron populations, and in any case any gains in electron populations ought to be redistributed by subsequent geomagnetic activity.

The corresponding electron fluence is therefore expected to remain below the Active (1e8 integrated pfu) threshold during the forecast period, but with a probable rising trend late in the period. This is reflected current REFM output.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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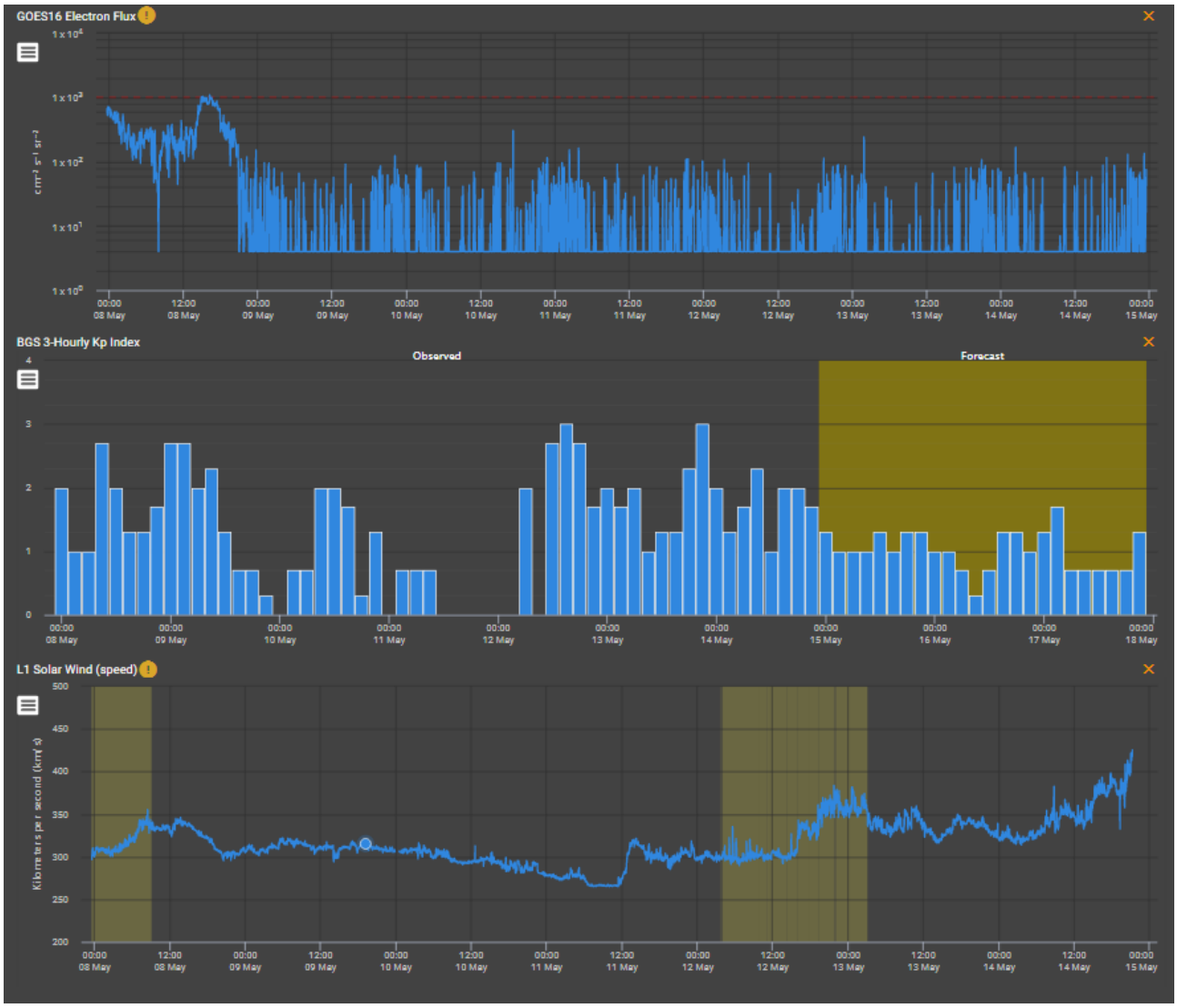
Figure 4: Past 7 days in GOES16 high energy electrons, top; Kp index from BGS (middle, including 3-day foreward look shaded yellow); and L1 solar wind speed (ACE shaded yellow). Occasional Kp3 intervals on 09 May resulted in Normal Background electron flux at GEO, with the subsequent slow solar wind incapable of generating any further enhancement.



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